Innovative Design of Vertical Axis Wind Turbine

a poster presented at DAMAS 2013 conference

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Published in:
10th International Conference on Damage Assessment of Structures (DAMAS 2013), July 8-10, 2013, Dublin, Ireland

Publication date:
2013

Document Version
Early version, also known as pre-print

Innovative Design of Vertical Axis Wind Turbine

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Introduction

The wind turbines can be classified as: i) Horizontal axis wind turbines (HAWT), and ii) Vertical axis wind turbines (VAWT). The HAWT is fully developed and the size is growing higher. Whereas, the VAWT is not developed because of the less efficiency and vibration issues of big structure. However, it is well known that the VAWT is advantages over a HAWT in terms of a cost and the simplicity (Paraschivoiu 2002). In this PhD project a simple blade design is incorporated by using the two-element airofoil technology for a three straight-bladed VAWT. The design considerations of a two airfoil are given, and its aerodynamic characteristics are obtained by an experimental method. A new design is called $D^2A - VAWT$ and a test ring is made to validate the numerical results. A double multiple stream tube method (DMSTM) and blade element method (BEM) are used to determine the numerical performance of a proposed $D^2A - VAWT$.

Objectives

The objectives of this PhD project are :

1. Improvement of mechanical efficiency and a self-start ability of a three straight-bladed VAWT.
2. Design a test ring of a proposed $D^2A - VAWT$ for validation of the numerical results.
3. Implementation of an active blade pitch control mechanism for a proposed $D^2A - VAWT$.

Methods

An experimental and a numerical method is used to design and develop an innovative three straight-bladed VAWT. A two-element airfoil blade design is incorporated in a proposed $D^2A - VAWT$ and a layout of two-element airfoil is shown in Figure 1.

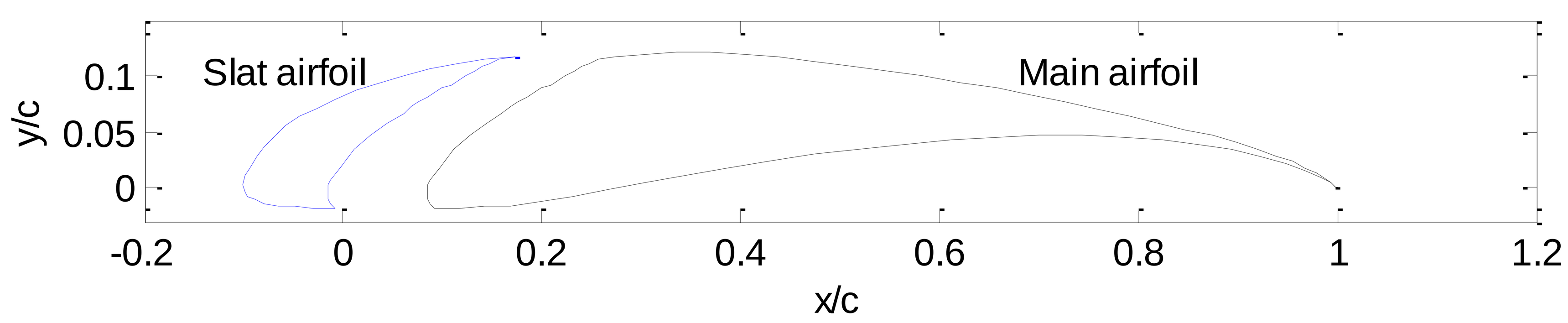

Figure 1.: S1210 single airfoil (SA) and design of S1210 two-element airfoil (DA)

The various methods used to achieve the objectives of PhD project are:

1. Experimental:
   a. A wind tunnel is used to obtain the aerodynamic characteristics of the designed two-element airfoil to validate numerical results.
   b. A test ring is made to obtain the performance of a proposed $D^2A - VAWT$.
2. Numerical: A Computational Fluid Dynamic (CFD) tool is used for simulation of a 2-dimensional flow over a designed two-element airfoil.
3. A DMSTM and a BEM is used to determine the performance of a proposed $D^2A - VAWT$.

Results

CFD simulation results for a single (SA) and a two-element airfoil are given in Figure 2.

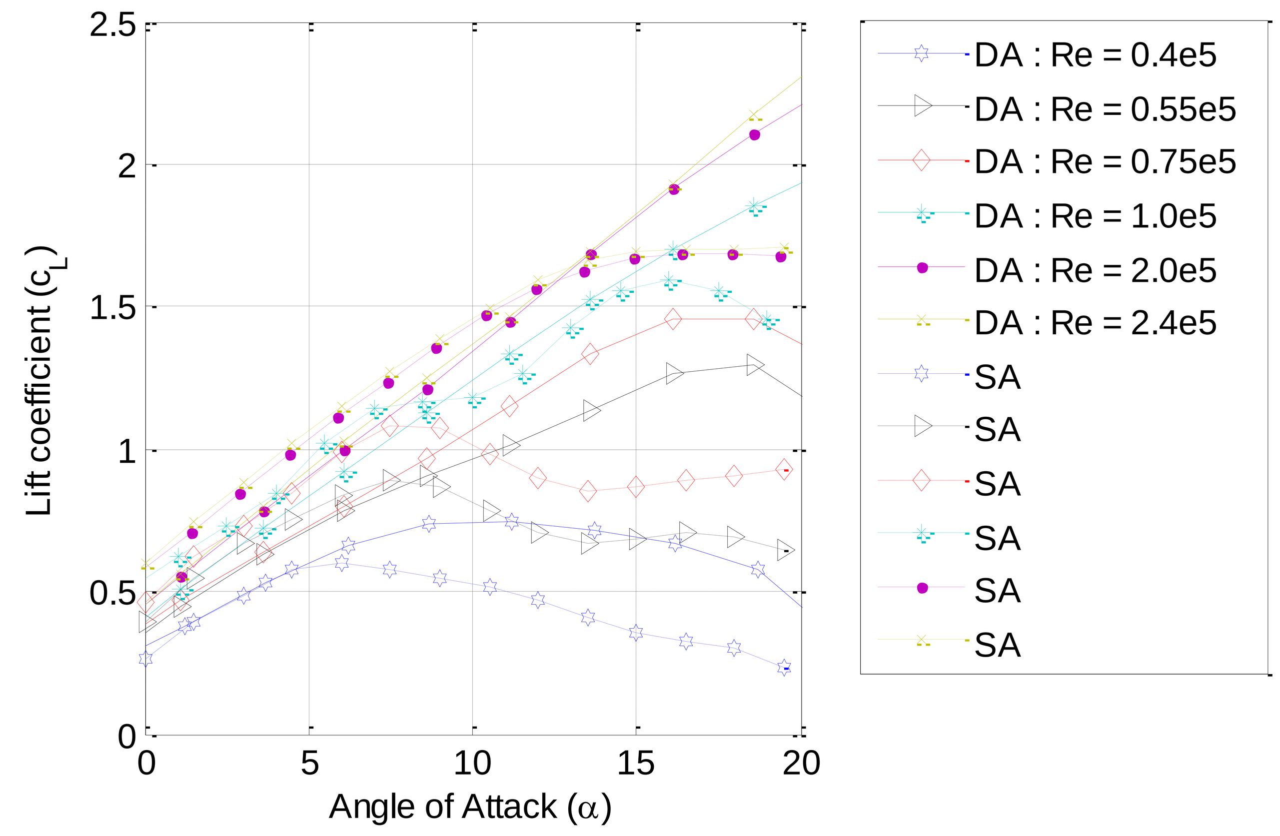

Figure 2.: Lift coefficient of a SA and a DA S1210 airfoil.

Performance of a reference VAWT (*Huskey et. al. 2009*) and a proposed $D^2A - VAWT$ is given in Figure 3

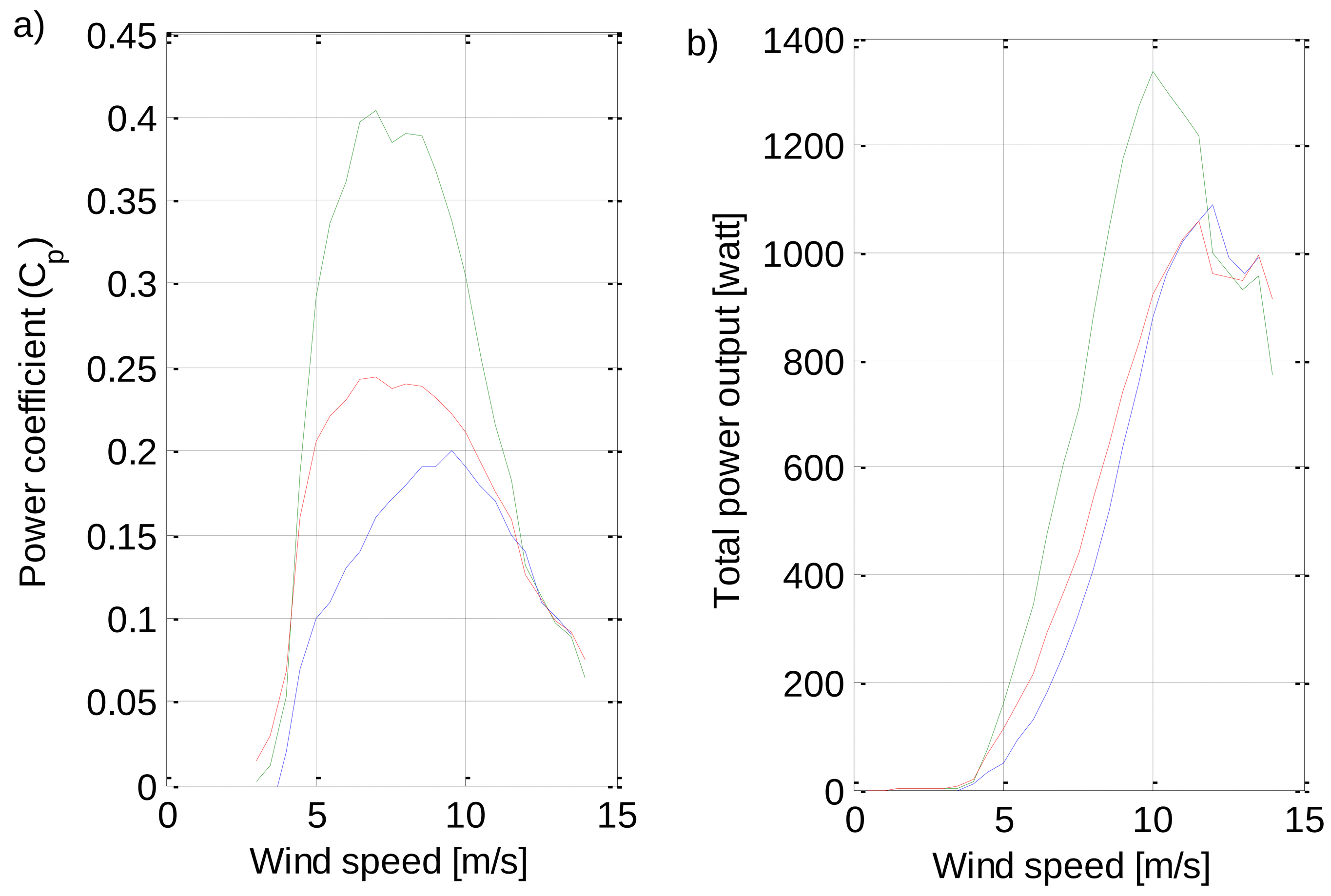

Figure 3. a) Power coefficent and b) Total power output.

: Measurements of a reference wind turbine .

: Numerical results of a reference wind turbine .

: Numerical results of a proposed $D^2A - VAWT$.

Conclusion

Two-element airfoil blade design is incorporated in a proposed $D^2A - VAWT$ to improve the power efficiency and self start ability of a reference VAWT. In this work only 2D aerodynamic characteristics of a single and a two-element airfoil are given which are validated by wind tunnel experiments. It is observed that the mechanical power efficiency of a three straight-bladed VAWT is improved to 40%. An experimental test ring is made and subsequently the testing will be carried out to validate the numerical results.

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The SYSWIND project (project no. 238325) funded by the Marie Curie Actions is acknowledged for the financial support under the grant Seventh Framework Programme for Research and Technological Development of the EU.

DAMAS 2013 10th International Conference on Damage Assessment of Structures

8th July - 10th July, Ireland, Dublin.

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